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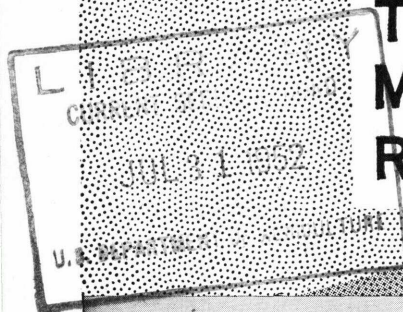
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RESEEDING

TO INCREASE
THE YIELD OF
MONTANA
RANGE LANDS



FARMERS' BULLETIN NO. 1924
U. S. DEPARTMENT OF AGRICULTURE

DEMANDS ON WESTERN RANGE lands have intensified a major problem confronting the livestock industry in Montana—the great need for more and better range forage. Additional range forage is required to produce necessary amounts of beef, lamb, wool, and hides. Today several million acres of range land are yielding only a small fraction of the forage they should produce. A considerable portion of the best of these consists of areas that have been plowed but then used only briefly for farm crops. An additional large acreage will need to be regrassed in the future, as the expanded acreage of wheat and other crops is adjusted downward in keeping with a stable agriculture.

How can some of these areas be restored to greater usefulness? Research and experimental tests by the Forest Service, and reseeded by other agencies and stockmen, have shown that many of them can be brought back quickly to better forage production through artificial reseeded. By comparatively inexpensive methods, it is usually possible to increase manyfold the grazing capacity of these lands within 2 to 4 years.

To safeguard against costly mistakes, however, and to insure reasonable and early success in reseeded at moderate expense, certain rules should be observed. This bulletin contains guides as to where, what, when, and how to reseed, for the use of Montana ranchers. The information given may also be helpful on other western ranges.

Washington, D. C.

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COVER PHOTOGRAPH—Formerly plowed Montana range restored to high grazing capacity by reseeded to crested wheatgrass. (F-418361)

RESEEDING TO INCREASE THE YIELD OF MONTANA RANGE LANDS

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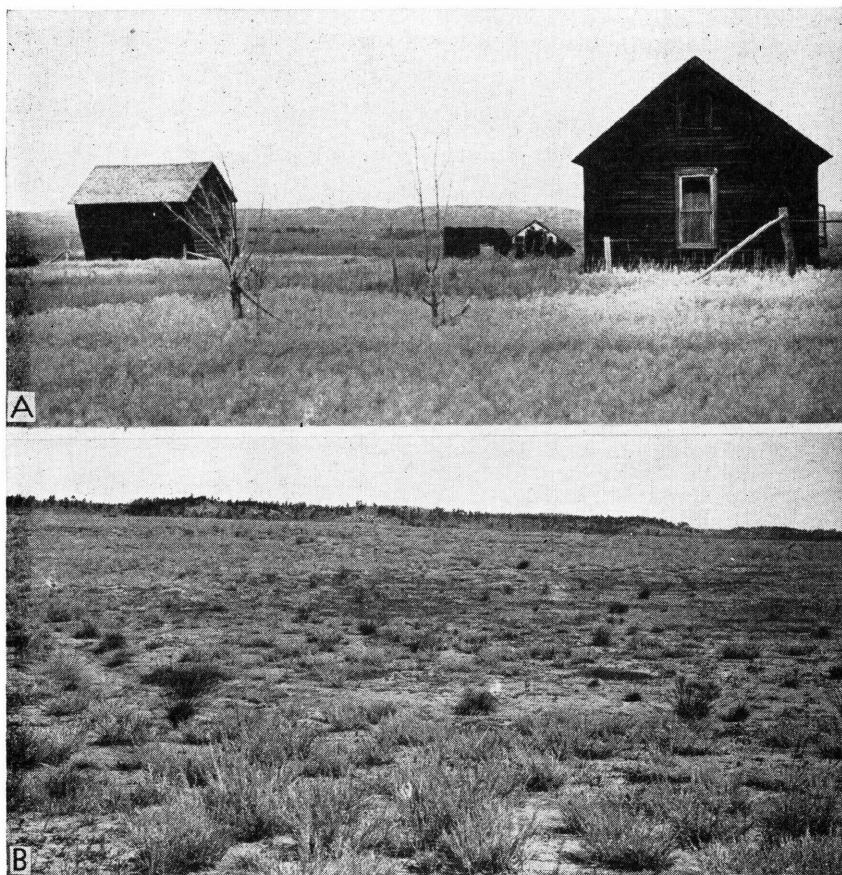
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INTRODUCTION

REGRASSING low-producing range lands in Montana, especially the extensive areas on which the original sod was destroyed by short-lived attempts to use them as croplands, is urgently needed because of present demands for increased livestock production. Restoration of these lands is important to the prosperity of the livestock industry. It is even more important to the economic welfare of the State. Over half of the gross agricultural income in Montana is derived from the livestock industry, which in turn depends largely on the cheap range forage required to support more than 1.6 million beef cattle, nearly 1.9 million sheep, and 150,000 horses. The supply of this forage is not now sufficient.

From 1900 to 1930, during periods of generally favorable wheat prices, about 4 million acres of range land, poorly suited for agricultural crops, was plowed for wheat production. During the thirties many of these farming attempts failed, chiefly because of recurring severe drought, and wholesale land abandonment, with its accompanying social and economic ills, followed (fig. 1). The forage-plant cover was satisfactorily restored on perhaps half of the plowed acres through artificial and natural reseeding before World War II. In order to meet wartime demands for wheat and other dry-land crops much of

¹ Certain phases of the station's research in artificial range revegetation are conducted in cooperation with the Montana Agricultural Experiment Station and the Bureau of Animal Industry, U. S. Department of Agriculture, at the U. S. Range Livestock Experiment Station near Miles City, Mont. Other phases, conducted elsewhere, are in cooperation with the Montana station and the Bureau of Plant Industry, Soils, and Agricultural Engineering, the Soil Conservation Service, and numerous ranchers and livestock growers.

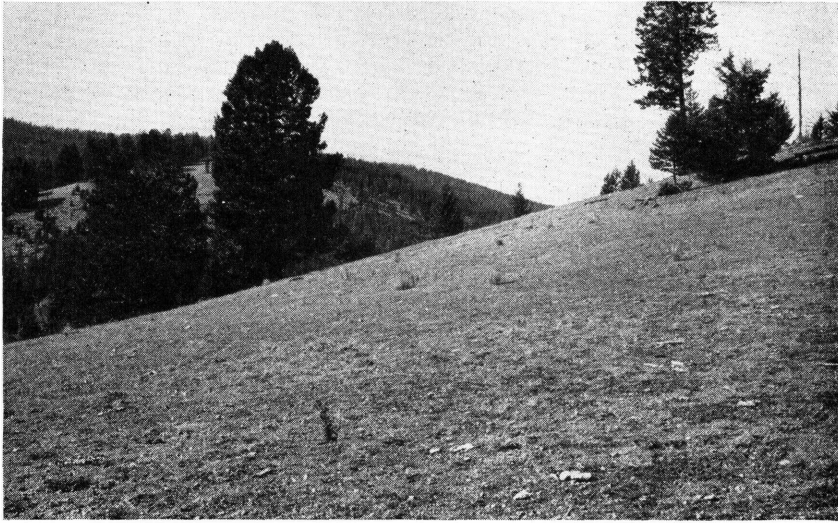


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FIGURE 1.—A, Reseeding is needed on numerous abandoned dry farms to replace weeds and cheatgrass with a dependable grass cover. B, In eastern Montana many such weed-covered, formerly plowed range lands have been successfully reseeded to forage species.

this restored range, and some previously unplowed range, was plowed. As a result, there still remains in Montana a large acreage of once-plowed land which is in need of reseeding. Revegetation by natural processes usually is extremely slow. The required period, ordinarily 20 to 50 years, varies with such factors as degree of soil and plant deterioration, available moisture, and intensity and season of use by livestock. No cure-all for the recovery of these ranges appears, but artificial reseeding, if carefully done, will in many instances bring about increased forage yields.

Unplowed range lands that have a low yield of forage constitute another problem of major importance. Can they be improved by reseeding? Frequently they can, although procedures have not yet been worked out for all situations. Of the several million acres of unplowed range land in a badly deteriorated condition, reseeding by present procedures is feasible on a large part. This includes ranges that have deteriorated severely through burning, too heavy grazing



F-402399

FIGURE 2.—Such deteriorated mountain parks as this can often be successfully reseeded.

(fig. 2), logging, and other disturbances, and cannot be restored within a reasonable time by good management and natural reseedling. The remainder can probably be restored through good management and other practices designed to increase the stand of native forage plants.

The Northern Rocky Mountain Forest and Range Experiment Station has carried on research in range reseedling since 1933, including experiments on more than 100 range areas in 27 Montana counties. The reseedling methods developed have been proved practical by reseedings by the Montana Agricultural Experiment Station and large-scale seedings by the Forest Service, the Soil Conservation Service, and hundreds of ranchers, often in connection with the Production and Marketing Administration's agricultural conservation programs. In all, more than 1¾ million acres of range land in Montana was successfully reseeded prior to 1950, but another 3 million acres is still in urgent need of revegetation. Results from the application of research findings and experience have been excellent, but the acreage reseeded annually must be increased if present and anticipated future needs are to be met.

CONDITIONS AFFECTING SUCCESS IN SEEDING

Success in range reseedling is favored where soil moisture is ample, topography is level or gently sloping, and soil is deep and fertile. Contrariwise, on extremely dry range lands, or on sites characterized by steep slopes and very thin or rocky soil, heavy runoff, abnormal erosion, and rapid drying, or where there are rather dense stands of competing vegetation, reseedling may be extremely difficult if at all justifiable.

The western third of Montana is characterized by rugged mountains, foothills, and intermountain valleys at elevations varying from

2,000 to 12,800 feet. These are in sharp contrast to the rolling and broken plains which occupy nearly all of the rest of the State, extending mostly below 4,000 feet from the eastern flank of the Rocky Mountains to the Dakotas. Largely as a result of variations in topography, soils, and climate, the native range vegetation of the western third of the State is distinct from that of the middle and eastern parts. The mountains are largely forested, and in the foothills and intermountain valleys the trees are interspersed with bunchgrass and some big sagebrush.² Ranges in western Montana are generally of the Pacific bunchgrass type. Such species as Idaho fescue and blue-bunch wheatgrass provide most of the forage.

On the plains east of the mountains the vegetation is composed chiefly of the shortgrasses. On some areas the shortgrasses are mixed with big sagebrush and other browse plants. Blue grama and blue-stem or "western" wheatgrass are two of the most important forage species in the plains. In some of the foothill and isolated mountain sections, such as the Bear Paws in north central Montana, range types are intermediate between those of the plains and the high mountains.

Climatic

Partly because of the variation in altitude, but also because of the barrier formed by the Rocky Mountains, there is a considerable difference in climate between Montana's two major topographical divisions. In the mountainous section, 40 to 65 percent of the total annual precipitation falls from April through September; in the plains 70 to 80 percent of the annual total falls during the same period. The average annual precipitation is 15 to 30 inches in the mountains, 11 to 18 inches in the intermountain valleys and foothills, and 11 to 15 inches on the plains. Summer temperatures average somewhat higher on the plains, particularly at night, than in the mountains, foothills, and valleys. On the other hand, average winter temperatures are lowest on the plains. Average wind velocities during the growing season are greater on the plains than in the mountains.

Climatic extremes in Montana generally do not prevent successful reseeding of ranges, though failures in some localities may be frequently due to weather. Grass seedlings of the most well-adapted species are able to stand great variations in temperature. While the sudden occurrence of very low temperature is likely to kill seedlings of even the native grasses occasionally, dry weather is a more serious hazard, especially when accompanied by high temperatures and hot winds. Though severe droughts are not frequent, they may prove fatal to tender seedlings of even the most drought-resistant reseeded species.

Uniform distribution of rain and snow through the year is far more important for reseeding success than total precipitation. Indeed, reseeding has been successful on some areas that received less than 10 inches of precipitation in the 12 months that followed planting. A good example is a formerly plowed range area near Ingomar, Rosebud County, that was reseeded in November 1933. Total annual

² A list of common and botanical names of plants mentioned in this bulletin appears on page 26.

precipitation was 4.29, 10.41, and 4.89 inches in 1934, 1935, and 1936, respectively; yet in spite of two extreme droughts in this period the area supported a good, thrifty stand of reseeded grass at the end of the third year.

Soil

Montana range lands are characterized by soils varying from sands to heavy clays and including raw, poorly developed, and even alkaline types. Fortunately, forage species are available for reseeding most of these soils. Some of them grow fairly well on several different soil types.

Crested wheatgrass, for example, has been established on a heavy clay soil at the United States Range Livestock Experiment Station near Miles City, Mont., and on some ranches in Garfield County, where it competed successfully with alkali-tolerant inland saltgrass. In Missoula County it has been established on the subsoil of a south-facing slope of a borrow pit from which 5 feet or more of soil was removed. Equally adverse conditions on road grades in Beaverhead County have not prevented establishment of this versatile species. It has thrived also on spots where brush was burned from clearings in Mineral, Sanders, and Ravalli Counties. Because of its ability to grow on exposed raw soils, crested wheatgrass is used extensively for reseeding skid roads and trails following logging operations in western Montana. Smooth brome is likewise adapted to a number of different soils, although it does not thrive on infertile soils or in extremely dry places. In general, the soils of most abandoned crop and deteriorated range lands are capable of producing good-quality forage once they are reseeded.

Competition for Soil Moisture

The chances for success in regressing range lands increase materially as competition for soil moisture by existing perennial vegetation decreases. On bunchgrass ranges competition will usually prevent the establishment of seedlings of artificially reseeded grasses when there is enough existing perennial vegetation to cover more than 15 percent of the soil surface. On range characterized by sod-forming grasses seedling establishment becomes uncertain when 7 percent of the soil is so covered. Reseeding is seldom justified when such an amount of ground cover includes a fair proportion of desirable grasses. If reseeding is attempted under such conditions, plowing, disking, or other means of reducing competition for soil moisture are necessary.

Cheatgrass brome (commonly called cheatgrass and known also as downy chess), which occupies thousands of acres of deteriorated range lands in Montana, presents especially difficult competition. This cool-weather annual commonly germinates and begins growth in the fall, becomes dormant during the winter, resumes growth early the following spring, and completes its life cycle by early summer. Consequently, cheatgrass competes severely with young grass seedlings for soil moisture during the critical spring period and stands must be reduced before seeding to insure success. Results to date have been so discouraging in thick stands of cheatgrass that such areas should not be reseeded unless special measures for reducing its competition

are taken. Where desirable perennial grasses of sufficient density prevail in such stands, management favoring these grasses will frequently restore forage production to a satisfactory level.

On the other hand, warm-weather or late-developing annual weeds, such as tumbling Russian-thistle, seldom compete severely with grass seedlings from fall or even early spring plantings. This is particularly true where a cool-weather species such as crested wheatgrass is reseeded, because such weeds usually start slowly in the spring and offer little competition for moisture during much of the critical early period in the life of grass seedlings. Numerous tests have demonstrated that satisfactory grass stands can be obtained economically by drilling directly into the Russian-thistle.

WHAT TO SEED

To be of general value for range reseeding, a forage species must be well adapted to a large area, relatively easy to establish, a fair producer of palatable herbage, and able to withstand considerable grazing use. Also, the seed must be available at a reasonable price and suitable for machine seeding.

As most reseeded areas are intended to supplement native forage on other range lands, consideration should be given to the type of forage already available and that needed in relation to a well-balanced plan of ranch operations. A highly palatable perennial species, seeded alone and supplying forage at the season when needed, usually meets these requirements best, and is therefore recommended over mixtures of two or more species for use in seeding plains, valley, and foothill ranges. On mountain range lands, however, particularly at high elevations, mixtures of adapted forage species are sometimes desirable. If native species are used for reseeding, seed grown in the same locality or in one having a similar climate should be obtained. Fluffy, chaffy, or awned seed, such as blue grama, tall oatgrass, and needlegrasses, will not feed through a drill unless first processed or "de-awned" in a hammer mill. When buying seed of such grasses, one should obtain "processed" or "de-awned" seed.

Table 1 lists some of the more promising species, as well as the particular conditions under which they may be seeded advantageously.

A few forage species, such as crested, bluestem, and intermediate wheatgrasses, smooth brome, and hard fescue, are so widely adapted that they can be used to advantage on both plains or foothill and mountain range lands. These grasses will therefore be considered first.

Crested Wheatgrass

Crested wheatgrass has been planted more extensively throughout Montana than any other range grass. It is well adapted to a wide variety of well-drained soils on the eastern plains and the western valleys, foothills, and mountains up to elevations of 6,500 to 7,500 feet. Other species are more promising above these elevations.

Test plantings of crested wheatgrass on more than 100 range areas throughout the State were successful despite such adverse conditions as extreme drought and heavy grasshopper infestations. Many

TABLE 1.—*Range forage species for reseeding deteriorated and formerly plowed range lands in Montana, with seeding rates recommended for seed of high purity and germination*

Species ¹	Description	Where to seed	Rate to seed per acre	
			Drilled	Broadcast
Blue grama-----	Hardy, drought-resistant, highly palatable, native perennial grass, with spreading fibrous roots. Sometimes difficult to establish. A warm-weather grass.	Best suited to the plains ranges. Not known to occur naturally west of Continental Divide in Montana.	Pounds 5-7	Pounds 6-8
*Big bluegrass-----	Long-lived, robust, perennial bunchgrass with extensive fibrous roots. A cool-weather grass, earlier than crested wheatgrass.	Does best in foothills, mountains, and valleys on burned, deteriorated, or formerly plowed ranges.	4-5	6-8
Beardless wheatgrass-----	Hardy, drought-resistant bunchgrass, native in western Montana. Highly palatable, more slender and tufted than closely related bluebunch wheatgrass. Not as early as crested wheatgrass but remains green longer in summer.	Deteriorated or formerly plowed range lands in the valleys and foothills throughout western half of Montana. Has same use as crested wheatgrass.	6-8	8-10
Bluestem wheatgrass-----	Long-lived native perennial that forms vigorous underground rootstocks; highly palatable. A cool-weather grass; poor seed producer; and somewhat difficult to establish.	Does best on medium- or fine-textured soils on bottoms, benches, and flats.	6-8	8-10
Crested wheatgrass-----	Hardy drought-resistant, long-lived, cool-weather perennial bunchgrass; easy to establish and a prolific seeder. Especially good for spring grazing. The most widely adapted species for range reseeding in Montana.	Deteriorated or formerly plowed range lands of the plains, valleys, foothills, and mountains up to 7,500 feet elevation throughout Montana. Good choice for dry places.	3-5	4-6

See footnote at end of table.

TABLE 1.—*Range forage species for reseeding deteriorated and formerly plowed range lands in Montana, with seeding rates recommended for seed of high purity and germination—Continued*

Species ¹	Description	Where to seed	Rate to seed per acre	
			Drilled	Broadcast
Green needlegrass.....	Rather coarse, leafy perennial bunchgrass with deep, fibrous roots. Remains green longer into the summer than most cool-weather grasses. Slow to germinate.	Deep, fine- or medium-textured soils in bottoms, swales, and on benches of plains or foothill ranges.	Pounds 5-6	Pounds 6-8
Hard fescue.....	Perennial bunchgrass with excellent root system; produces durable turf on deteriorated soils. Easy to establish.	Sandy, gravelly or medium-textured soils of mountains, valleys, foothills, and plains.	3-5	4-6
Intermediate wheatgrass.....	A cool-weather perennial; mild sod-former; nearly as early as crested wheat, which stays green longer into the summer. Less drought-resistant than crested wheatgrass but more so than smooth brome.	Suited only to best sites throughout plains, foothills, valleys, and mountains where precipitation is at least 15 inches annually.	5-6	6-8
*Mountain brome.....	Robust, short-lived perennial bunchgrass with deep, fibrous roots. Re- produces by seed only. All livestock relish early growth and large seed heads.	Depleted mountain range lands at medium and high elevations, particularly where the subsoil is exposed.	8-10	10-12
*Orchard grass.....	Long-lived, highly palatable perennial bunchgrass with deep, fibrous roots; moderately drought-resistant. Tolerates some shade.	Does well where better-than-average moisture conditions prevail on deteriorated mountain and valley ranges.	4-6	5-7

*Stiffhair (pubescent) wheat-grass.	A mild, sod-forming perennial, easy to establish and capable of producing good yields on sites of low fertility and rainfall.	Deteriorated or formerly plowed mountain, valley, or foothill range lands. Does well also at high altitudes.	6-8	8-10
Russian wild-rye-----	Hardy, deep-rooted, long-lived perennial bunchgrass. Basal leaves remain green throughout summer, somewhat difficult to establish, but drought-resistant. Poor seed producer.	Medium-textured soils of mountains, foothills, and valleys; well suited to arid places.	7-8	8-10
*Smooth brome-----	Long-lived perennial sod-former; spreads chiefly by underground rootstocks. Of high grazing value and relatively easy to establish except in drought years. Once established, it endures cold and drought well.	Best used on deteriorated mountain ranges (except on lower, drier slopes) and on formerly plowed ranges where average annual rainfall is 15 inches or more. Does well in swales in eastern Montana.	6-8	8-10
*Tall oatgrass-----	Deep-rooted, moderately long-lived, robust perennial bunchgrass; produces large amount of forage. Seed sown more easily if de-awned, or mixed with other species.	Deteriorated mountain ranges, especially at medium and high elevations. Does best on moister sites.	5-7	6-8
*Timothy-----	Hardy perennial with fibrous roots; reproduces only by seed. Produces large volume of excellent forage on moist soils. Best used in a mixture.	Does well in the mountains where soil moisture is favorable. Should not be used in drier places in the valleys or foothills.	3-4	4-6

¹ When used in plantings at medium and high elevations in the mountains or on burned-over or logged-over timberlands, each species marked with an asterisk (*) does well in mixture with two or more of the other species marked the same way. If mixtures are used, the rate to sow per acre is determined by taking the proportionate amount of seed recommended for each species when planted in a pure stand.

plantings were made on formerly plowed foothill and plains ranges during the severe drought period of 1934-36. Crested wheatgrass, introduced into this country from Russia, is most readily established on abandoned croplands (fig. 3) and areas where sagebrush or cheatgrass has been removed by plowing or where fire has destroyed big sagebrush or timber.

Not only does crested wheatgrass withstand drought and low temperatures well, it also competes successfully with weeds and becomes established more readily than most other species (fig. 4). A long-lived bunchgrass that makes early and rapid growth in the spring, it becomes dormant during summer and renews growth when soil moisture is replenished by fall rains. Because it is a prolific seed producer, sparse stands often thicken up satisfactorily through natural reseeding.

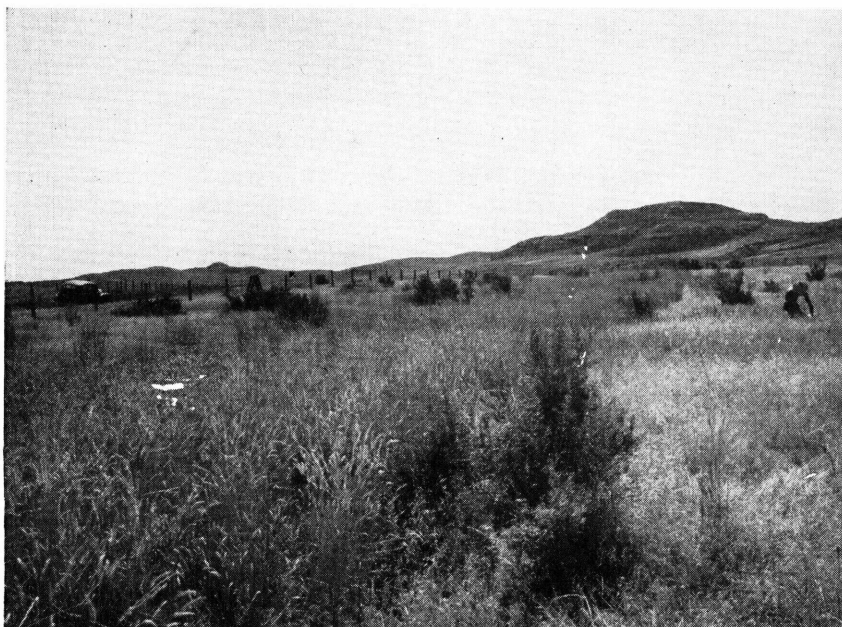
New growth of crested wheatgrass is palatable to range livestock of all kinds and is especially valuable in a calving or lambing pasture, as it may be grazed two or more weeks earlier than most native species. Cattle graze mature stems in the fall, along with green basal leaves that are produced after late summer or early fall rains. If ungrazed until seeds begin to form, however, it becomes coarse, stemmy, and rather unpalatable. Cut for hay before or during the flowering stage, crested wheatgrass is equal in quality and palatability to most types of native-grass hay.

Crested wheatgrass seedlings develop slowly the first season except under particularly favorable conditions and may easily be overlooked in casual examination. In dry seasons, the seed may not germinate. Plantings that later produced good stands have frequently been reported as failures the first growing season. It is well, therefore, to reserve judgment of success at least until the second growing season.



F-463186

FIGURE 3.—Crested wheatgrass drilled on formerly plowed range land at the United States Range Livestock Experiment Station, Miles City, Mont., still furnished an abundance of high-quality forage to cattle 14 years after planting.



F-463181

FIGURE 4.—Barely a trace of weeds and cheatgrass remains in the strip (left) seeded to crested wheatgrass in the fall of 1938, while in the untreated strip (right), cheatgrass continues to dominate the area 12 years later.

Bluestem Wheatgrass

Bluestem wheatgrass, or western wheatgrass as it is more often called, is widely distributed throughout the plains, foothills, and mountain valleys of Montana. It is the most important native forage species over much of the plains section of the State, where it frequently grows in almost pure stands on fine-textured soils and bottom lands. On medium-textured soils, it is usually associated with blue grama and needle-and-thread grass.

In eastern Montana bluestem wheatgrass is the dominant native species in wild-hay meadows. It is a long-lived perennial that produces spreading, underground rootstocks, forming an open sod. Like crested wheatgrass, it is a cool-season grass, and makes early and rapid growth in the spring, becomes dormant during summer, and resumes growth if soil moisture is replenished by fall rains. It is drought-resistant but also has the ability to grow luxuriantly when moisture conditions are favorable.

Bluestem wheatgrass herbage rates high as range forage for cattle and horses the year round. Sheep graze it sparingly, except while it is succulent and green in the spring and early summer and after the seed has ripened in early fall. It is valued as winter forage for all classes of range livestock because it cures well on the ground and is often available when shorter herbage is covered by snow.

Bluestem wheatgrass is often the first of the native perennial grasses to reinvade formerly plowed foothill, valley, and plains ranges. It will survive submersion by flood water for several days and for this reason bluestem wheatgrass is particularly useful in reseeding heavy clay or "gumbo" flats that are subject to overflow, or where water spreading is contemplated. It is a sod former and an excellent soil binder on dykes and waterways. Seed germination requires a long period of cool, moist conditions; hence, the time required to obtain a full stand may be greater than with some other grasses. However, when a partial stand is established, it will thicken up rapidly by spreading from underground rootstocks.

Intermediate Wheatgrass

Intermediate wheatgrass, a perennial sod former, introduced from the Soviet Union, has shown up well under a wide range of conditions in the mountains, valleys, and foothills. It begins growth in the early spring and is ready to graze nearly as early as crested wheatgrass. It remains in the vegetative stage of development somewhat longer than many other forage species, and reaches the flowering stage 2 to 3 weeks later than such species as crested wheatgrass, smooth brome, and bluestem wheatgrass. After a dormant period during hot summer weather, growth is resumed in the fall if soil moisture is available. Heights of flowering stalks at maturity range from 3 to 4 feet under favorable conditions.

Intermediate wheatgrass is somewhat more drought-resistant than smooth brome, but less so than crested wheatgrass. It produces an abundance of leafy foliage that is relished by range livestock. In test plantings in the foothill ranges of the Bitterroot Valley in western Montana, and in the Judith Basin of central Montana, intermediate wheatgrass has consistently outyielded crested wheatgrass. On the basis of its performance in tests, intermediate wheatgrass should fill an important role in the rehabilitation of deteriorated or formerly plowed range lands of Montana, particularly where moisture conditions are favorable. Increased seed production is expanding the present limited supply available for reseeding purposes.

Smooth Brome

Smooth brome, originally from central Europe and now widely grown in this country, is a vigorous, long-lived forage plant of high grazing value. Under favorable conditions it sends out many underground rootstocks to form a dense sod. For best growth it requires soil moisture ordinarily obtainable on mountain range lands at elevations greater than 5,000 feet. It has been grown successfully in the lower foothills and western edge of the plains where average annual precipitation is more than 15 inches and in swales and depressions farther east with even less rainfall. During dry seasons it has been much more difficult to establish than crested wheatgrass. Once a stand is established, smooth brome endures drought and low temperatures remarkably well. A questionable choice in many localities because of low rainfall, smooth brome is one of the outstanding



F-465256

FIGURE 5.—Lincoln smooth brome (left) and hard fescue (right) produced good cover and high herbage yield in range reseeding plots. Judith Basin County, Mont.

species for use where soil moisture is adequate (fig. 5). It can be grown on sandy soils, though best results are obtained on fertile clay and sandy loam soils. Seed of improved strains can usually be obtained from seed dealers.

Hard Fescue

Hard fescue is another grass introduced from Europe that appears to have a definite place in reseeding Montana range lands. It is a perennial bunchgrass with an excellent root system and grows better than most grasses on sandy or gravelly soils. Not only is it well adapted to valleys, foothills, and the ponderosa pine zone of western Montana, but it also does well on the medium-textured and gravelly soils of the plains.

Hard fescue is a robust, high-producing variety of the common sheep fescue. Cattle and sheep make satisfactory use of this species while it is green, but perhaps its chief attribute is its ability to produce a deep-rooted, durable turf on deteriorated soils. At present, seed may be difficult to obtain, but the ease of establishment and the strong seed-producing characteristics of this species should soon overcome this handicap.

Other Species Adapted to the Plains

A few forage species other than those already discussed have given good results on formerly plowed or deteriorated range lands of the plains.

Blue grama, one of the most valuable and widely distributed native grasses on the plains ranges of eastern Montana, is particularly well adapted to medium-textured soils. It is a hardy, drought-resistant perennial with spreading fibrous roots, forming a sod under some conditions. Blue grama is a warm-season grass, most of its growth being made during late spring and early summer. For this reason, a relatively clean seedbed is essential, since both warm- and cool-season weeds offer serious competition for soil moisture during the period of seedling establishment. It has a very small seed, which must be shallow-planted. Being fluffy, the seed is difficult to handle, but it is easy to sow if first run through a hammer mill to remove the seed coat and break up the florets. Blue grama is rated a choice forage species for all kinds of range livestock. Without question, it is adapted to most plains ranges, and it should be used more generally, particularly where cool-season grasses predominate.

Green needlegrass is a rather coarse, leafy perennial bunchgrass, native to the plains and foothills of eastern Montana. Its deep fibrous root system makes it particularly well adapted to the deeper soils of fine- or medium-textured bottomlands, benches, and swales. It is also adapted to upland slopes on soils of medium texture. Seedlings are vigorous and reasonably resistant to drought. Green needlegrass starts growth early in the spring, and remains green well into the summer, commonly growing to a height of 3 feet. The leaves are mostly basal and attain a height of from 8 to 12 inches. It provides good forage for all kinds of range livestock, and makes excellent recovery after grazing.

The seed awns of green needlegrass are not so long or troublesome as those of most other needlegrass species and can be effectively removed by processing and cleaning. It is a moderately strong seed producer, but freshly harvested seed does not germinate readily. This can be overcome by dry storage for a year.

Because it is well adapted to many plains soils and produces good-quality green forage farther into the summer than many other forage species, green needlegrass has a definite place in reseeding Montana's plains.

Other Species Adapted to Mountain, Foothill, and Valley Ranges

Beside crested wheatgrass, bluestem wheatgrass, intermediate wheatgrass, smooth brome, and hard fescue, already discussed, species of proven value for reseeding deteriorated mountain, foothill, or intermountain-valley range lands in Montana include tall oatgrass, mountain brome, orchard grass, timothy, stiffhair (pubescent) wheatgrass, beardless wheatgrass, big bluegrass, and Russian wild-rye.

Tall oatgrass, a perennial bunchgrass introduced from Europe, is particularly well adapted to mountain range lands where soil moisture is usually more abundant than on the plains. Although short-lived, it is a good seed producer and under moderate grazing use reproduces itself satisfactorily. Tall oatgrass grows best on deep, medium-textured soils, where runoff and evaporation are not excessive. It also does rather well on thin, gravelly soils in the ponderosa pine zone following logging operations. Where adapted, it surpasses crested

wheatgrass in herbage yield. A mixture of these two species, seeded on a deteriorated range on the Lewis and Clark National Forest, produced a dominant stand of tall oatgrass in a draw (fig. 6), but on nearby exposed, well-drained slopes crested wheatgrass was dominant.

Tall oatgrass produces an abundance of good-quality herbage early in the spring. It keeps growing and green until late autumn. The fluffy, awned seed is difficult to harvest and commonly shatters before it is fully mature. The Tualatin strain of tall oatgrass, developed in Oregon, is leafier and somewhat later in development; the seed shatters less readily than in the common strain. Sowing is more readily accomplished if seed coats and awns are first removed.



F-402402

FIGURE 6.—Broadcast seeding produced this stand of tall oatgrass on deteriorated mountain ranges. Lewis and Clark National Forest.

Mountain brome is a vigorous perennial bunchgrass, native to the Rocky Mountain and Pacific Coast regions. It is well adapted to burned-over timberland and erodible sloping areas in the mountains where rapid establishment of a cover is desired. It is rather short-lived, but reseeds itself satisfactorily under favorable conditions, and produces a large amount of good-quality herbage. Bromar mountain brome, recently developed in the Pacific Northwest, is a leafy, highly productive, smut-resistant strain.

Orchard grass, introduced from Europe, is a long-lived perennial bunchgrass that has given very good results on deteriorated mountain ranges where better-than-average moisture conditions prevail. It is very shade-tolerant and does well on light soil of medium fertility at medium to high elevations. Orchard grass is especially promising for use on burned-over timberland and skid trails and landings of logged areas in the ponderosa pine-Douglas-fir type. It is one of the first grasses to start growth in the spring, and, with sufficient soil moisture, continues growth until the first severe frosts. Where adapted, it is one of the easiest species to establish by reseeding, and it produces an abundance of high-quality herbage.

Timothy is a perennial bunchgrass, introduced from Europe during colonial times. It is shade-tolerant and well adapted to mountain range sites at all elevations with medium- or fine-textured soils where soil-moisture conditions are favorable. Under these conditions, timothy begins growth early, and produces a good quantity of high-quality herbage well into the fall. It is a prolific seed producer, and the seedlings develop rapidly.

Stiffhair (or pubescent) wheatgrass, introduced from Russia, is a perennial of considerable promise on deteriorated or formerly plowed mountain, valley, or foothill range lands. It is a mild sod-former, similar to intermediate wheatgrass in growth habits, but capable of producing greater herbage yields on sites of low fertility or under low rainfall. It does well also at high elevations. Pubescent wheatgrass is easy to establish. Seedling vigor is good and development rapid. As forage, it is similar to most other wheatgrasses. Seed is being grown commercially, but it is still in short supply.

Tall wheatgrass, a rather coarse but vigorous bunchgrass, introduced from Russia, has done well on deteriorated mountain range lands, particularly at elevations above 5,000 or 6,000 feet. It is successful on sites somewhat drier than those required for smooth brome, timothy, and orchard grass. Though tall wheatgrass starts growth early, it remains green longer and matures later than most other grasses. Despite its coarseness, tall wheatgrass is taken reasonably well by both cattle and horses; where adapted, it produces large quantities of forage. Seed is now being grown commercially in limited quantities.

Beardless wheatgrass is a hardy perennial bunchgrass native to western Montana. It is closely related to bluebunch wheatgrass, but is awnless. Although well adapted to rather dry valleys and foothills, it is slow to develop good stands from seedlings. It is highly palatable but intolerant of heavy grazing use; new stands should not be grazed until the third year. Beardless wheatgrass starts growth later in spring than crested wheatgrass. It remains green longer in summer. The improved Whitmar strain, which is more drought-resistant than crested wheatgrass, was developed from numerous specimens collected from natural stands. Limited seed supplies are available commercially.

Big bluegrass is a long-lived, robust, perennial bunchgrass, native to our Western States. It has done well on skid roads and trails and on burned-over timberlands, as well as on deteriorated and formerly plowed range lands in the mountains, foothills, and intermountain valleys, under a wide range of physical conditions. Big bluegrass begins growth in the early spring; it is ready to graze even earlier than crested wheatgrass. Too early grazing, particularly of new stands, is extremely injurious, however, because the plants pull up when the soil is loose or very wet. Under favorable soil-moisture conditions an abundance of high-quality herbage is produced, which remains green well into the summer. Seed production is very good. Plant selection work in Oregon has resulted in development of the improved Sherman variety of big bluegrass. Seed of this improved variety is now available in limited quantity.

Russian wild-rye is a hardy, deep-rooted, long-lived perennial bunchgrass, introduced from Russia, that is well adapted to medium-textured soils of the mountains, foothills, and valleys. It is more

productive than other species such as smooth brome, timothy, big bluegrass, and tall oatgrass on the more arid sites. Though more difficult to establish than crested wheatgrass, it withstands drought remarkably well. Russian wild-rye starts growth in the spring somewhat later than crested wheatgrass, but matures its seed earlier, and the basal leaves commonly remain green throughout the summer, long after most other grasses have dried and cured. Seed is relatively expensive.

WHEN TO SEED

The best time to seed varies with species, locality, and cultural methods. Late fall seeding is ordinarily superior to spring seeding on foothill, valley, and plains ranges for all grasses discussed here except blue grama, when plantings are made without seedbed preparation. Blue grama is best seeded in midspring. Spring is the best time to seed at middle and high elevations in the mountains, and on clean, freshly prepared seedbeds throughout the State.

Late fall seeding should be done somewhat in advance of the time the ground usually freezes, but not so early that fall germination is likely. Spring seeding should be started as soon as possible after the frost goes out of the ground and the soil dries sufficiently to be worked. This will best enable the seedlings to pass through the tender early-season stage of development before late-spring or early summer drought occurs.

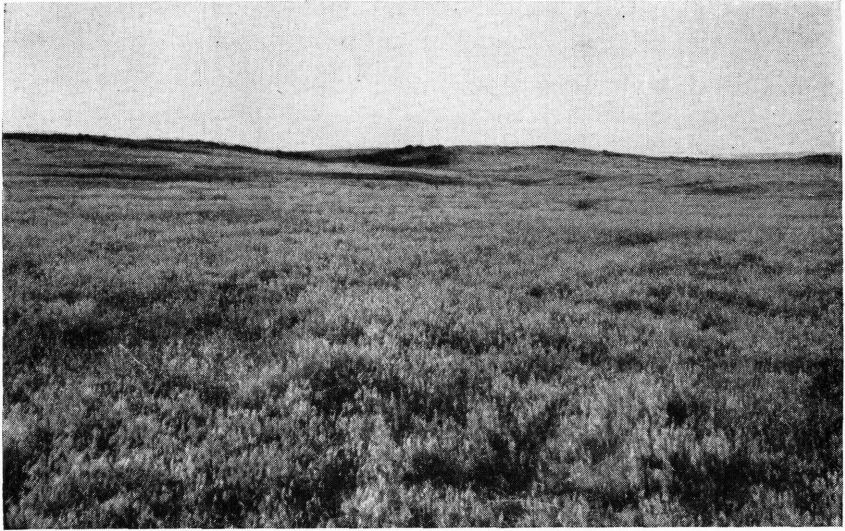
HOW TO SEED

Seedbed Preparation

Vegetation that will seriously compete with seedlings during the critical establishment period following germination can be reduced or removed by tillage, use of preparatory crops, and planned burning. Accordingly, before reseeding is attempted, range areas heavily infested with cheatgrass (fig. 7) or other undesirable cool-season plants must be tilled or otherwise treated to reduce the vegetation that competes for soil moisture. Where Russian-thistle or other warm-season annuals are present, however, treatment to reduce competition is usually unnecessary, except where a warm-season forage species like blue grama is to be seeded.

Tillage is most effective in the spring, soon after frost goes out of the ground and soil has dried sufficiently for good tilth. At that time growth of such cool-season annuals as cheatgrass has already begun, and a greater kill is obtained than in the fall. However, mid- or late-fall tillage is usually satisfactory, for even though the reduction in competition may be somewhat less, seeding at a more favorable time for cool-weather forage species is permitted.

The brushland plow, an implement developed by the Forest Service (fig. 8), is very effective for reducing competition in heavy stands of big sagebrush. This plow has pairs of disks mounted at a pitch or angle on an arm held in place by a spring. The pitch of the disks gives a better cutting action and a higher percentage of brush kill than wheatland-type plows. The spring-controlled arm allows the pairs of disks to rise independently over rocks and brush piles without



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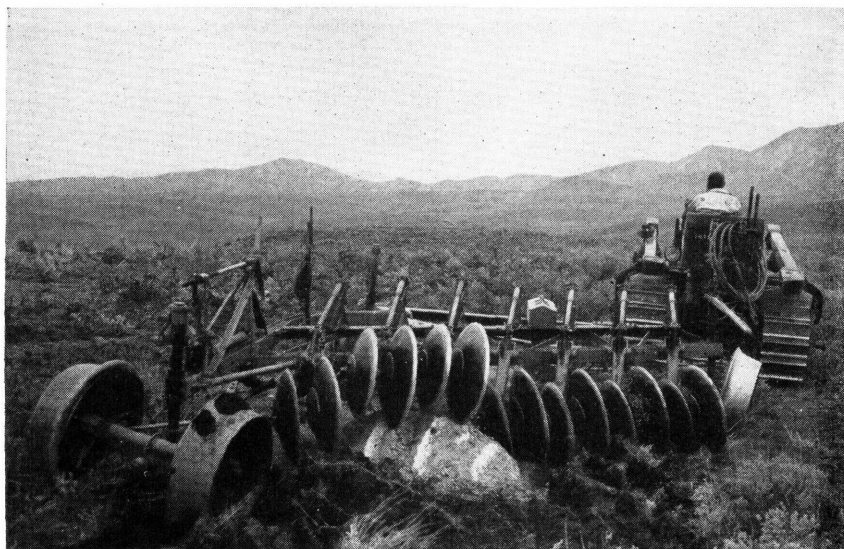
FIGURE 7.—Thousands of acres of formerly plowed range are covered by thick stands of cheatgrass like this. Tillage to eliminate such competition is necessary before seeding.

breakage and strain on the plow and with almost no clogging. Heavy offset disks have also been used effectively for seedbed preparation in stands of big sagebrush.

The preparatory-crop method of seedbed preparation consists in preparing a clean seedbed; growing and harvesting a cereal grain crop, preferably for hay but often satisfactorily for grain; then drilling seed of forage species directly into the stubble. An outstanding advantage of this method is that it provides a prompt cash return usually sufficient to cover costs of the entire reseeding operation. It is particularly adapted to the extensive acreage of formerly plowed range land now supporting heavy stands of cheatgrass.

Planned burning is well adapted to the removal of heavy stands of big sagebrush from areas to be reseeded. It should be used only where 50 percent or more of the plant cover is composed of big sagebrush and the understory of perennial grasses and weeds covers less than 20 percent of the soil surface. Sprouting species of brush cannot be effectively removed by planned burning. Necessary precautions are as follows:

1. Limit the area to be treated to a size that can be spared from grazing use for two or three seasons.
2. Treat only areas with gentle slopes, where reseeding will be practicable and excessive erosion will not occur.
3. Construct adequate fire lines, 30 feet wide, with an additional 200-foot burned-out strip.
4. Protect the area from grazing use during the summer it is to be burned. The purpose is to have sufficient combustible material present by late summer or early fall so that the fire will carry successfully and result in a satisfactory kill of big sagebrush.



F-454230

FIGURE 8.—The brushland plow effectively reduces competition in heavy stands of big sagebrush. Reseeding such areas to an adapted forage species is a good means of restoring herbage production on low-value range lands.

5. Obtain a drill and sufficient seed of an adapted range forage species so that reseedling can be completed in the fall, after burning.

Burning is also a useful means of disposing of slash and preparing a satisfactory seedbed on logged-over timberlands. This, of course, must be done during a season of no forest-fire danger.

Satisfactory stands of grass may often be obtained without seedbed preparation if competing vegetation is not present. Many formerly plowed range areas have been successfully seeded to cool-weather grasses such as crested wheatgrass by drilling the seed on an unprepared seedbed bearing Russian-thistle and other late-developing annual weeds. Some shading of the new plants by Russian-thistle may be of advantage. One test in eastern Montana showed that surface temperatures of bare soil frequently exceeded 120° F.—higher than young grass seedlings can long endure—but in the shade of Russian-thistle growth surface temperature was 12° to 44° F. lower. However, where the old weed growth is so thick that it chokes the drill, it may be necessary to rake the area before continuing the work.

Burning weeds or stubble to make seeding easier is not recommended; they afford new seedlings needed protection against drying winds, minimize wind erosion, and return needed organic matter to the soil.

In numerous other instances seedbed preparation has proved unnecessary on raw or freshly disturbed soil or on fresh timber or brush burns. On a recently logged national-forest area in southwestern Montana, for example, burned areas and skid roads were successfully broadcast-seeded in both spring and fall, without further seedbed preparation or special covering of the seed. Another example is the



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FIGURE 9.—A, Part of Henry Creek burn in October 1944, 3 months after fire. Note thick timber stand, complete kill, bare soil—conditions favorable for seeding. B, Same general location on Henry Creek burn, with excellent cover of palatable herbage in second growing season after seeding by airplane. Photographed in August 1946.

Henry Creek burn, on the Cabinet National Forest in western Montana (fig. 9), where a densely forested area, devastated by fire, was successfully broadcast-seeded by airplane. In both instances the seed worked down into the loose soil or ashes and was satisfactorily covered.

Seeding

Drilling is the best means of planting forage species if the soil surface and topography are suitable (fig. 10). Use of a drill insures more uniform distribution, depth of planting, and covering of the seed, so that a smaller quantity of seed per acre is needed. The single-disk drill has a decided advantage if it is necessary to cut through weed growth in placing seed in the soil. If weeds or surface debris are not present the furrow drill is best, particularly for fall seeding, as the furrows tend to hold snow and thereby increase moisture available to the seedlings the following spring.



F-463140

FIGURE 10.—A single-disk grain drill used for seeding intermediate wheatgrass on deteriorated big sagebrush range after the sagebrush was removed by plowing.

Special grass-seed attachments for ordinary grain drills are unnecessary for most grasses. Even very small-seeded species can be planted satisfactorily with a grain drill after the seed is mixed with 2 to 4 parts of a carrier such as sawdust or rice hulls. Blue grama seed may be sown in this way, although results are more satisfactory if the seed coats are removed before seeding. In reseeding formerly plowed or deteriorated range land every other drill feed should be stopped to space the seed rows approximately 12 inches apart. This spacing is close enough to produce a closed stand of vigorous plants on favorable sites. Furthermore, the wider spacing requires less seed per acre. At Miles City, an experiment with 6-, 12-, and 30-inch row

spacings showed that after the stand was well established total herbage yields were about the same for all spacings. Seed production was greatest with the wider spacings, but weed growth was also greater than where rows were more closely spaced. Mortality from drought was greatest for the 6-inch spacing and least for the 30-inch spacing.

Where site conditions prevent the use of a grain drill, broadcasting may be satisfactory, provided the seed is covered. A "cyclone" hand seeder (fig. 11) often serves very well on skid roads, dikes for spreading water, road shoulders, sheep bedgrounds, and even on larger areas where timber or brush types have been burned.

There are several other types of broadcasters which are satisfactory on seedbeds that are too trashy, brushy, or rocky for effective use of a drill. Most common of these is the rotary broadcaster, adapted from grasshopper bait spreaders, with either a traction or a motor-powered takeoff. It can be used either immediately behind disks or brushland plows or on any freshly tilled or burned area. If the disking or plowing is less than 2 inches deep the seed should be broadcast ahead of the disk or plow.

Airplane broadcasting is sometimes the only practicable means of seeding inaccessible mountain lands where heavy stands of timber or brush have been destroyed by fire (fig. 9). Satisfactory results are obtained only if the seed is broadcast from the airplane in the fall, soon after the fire while the ashes are fresh and sufficiently loose to form a seedbed into which the seed will work.



F-410504

FIGURE 11.—Mountainous sites such as this skid road on a western Montana logged area are conveniently seeded with a "cyclone" hand seeder.

Depth to Seed

Seedlings which grow in the bottom of furrows $1\frac{1}{2}$ to $2\frac{1}{2}$ inches deep are below the quick-drying surface soil and have an advantage over seedlings or competing plants growing near the soil surface. The furrows collect moisture and partially protect the young seedlings from sun and wind. Where annual plants such as cheatgrass are present, seeding in an even deeper furrow puts the seedlings in a lower root zone, freer of competition.

Seeding depth or depth of drill furrows will depend upon the soil type, season of seeding, and competing vegetation. Where the soil is such that furrows may become filled by soil blowing or soil sloughing, seed which was originally covered to a depth of one-half inch in the bottom of the furrow may be covered too deeply. Where this soil movement takes place only during the winter, this difficulty may be avoided by spring seeding.

Covering the Seed

Covering the seed, regardless of the way it is sown, is essential. Drilling covers the seed automatically. If broadcast on a firm seedbed, seed should be covered by some means such as disking, spike-tooth or spring-tooth harrowing, brush dragging, or on very small areas, hand raking. On a loose, freshly prepared seedbed, or in the ashes of a recent burn, weathering and natural settling of the soil will often cover seed adequately. This is also true on newly constructed water-spreading dikes, contour furrows, and other surfaces where loose mineral soil is exposed.

Large-seeded range grasses should be covered to a depth of three-fourths to one inch. For a very small-seeded species, such as blue grama, a depth of one-half inch or less is recommended. While very shallow depths of covering often give the best germination, most of the seedlings that result may die from rapid drying out of the surface soil. On the other hand, covering to more than the recommended depth will reduce the number of seedlings established. If a furrow drill is used, care must be taken not to cover the seed too deeply. Depth of original covering with the furrow drill can be reduced by removing the drag chains.

Rate to Seed

The rate of seeding that will give best results depends upon the species used, the purity and viability of the seed, and the method of seeding. Species having large seeds and fewer of them per pound, such as intermediate wheatgrass, obviously require a greater weight of seed per acre than smaller-seeded species such as crested wheatgrass. Again, a greater weight of seed is required if the purity and germination percentages are low. For example, on a per-acre basis 5 pounds of seed with a purity and germination percentage of 95 each will give about the same result as 10 pounds of the same species having a purity percentage of 90 and germination about 50 percent. As indicated in table 1, drilling requires less seed per acre than broadcasting.

MANAGEMENT OF RESEEDED RANGE LANDS

The management of reseeded range lands includes the treatment and practices required to obtain a satisfactory stand of grass within a reasonable time and management thereafter for sustained production.

During the period of establishment, from the time of germination until the reseeded stand is producing satisfactorily, protection from unregulated grazing use is essential. Since best management of reseeded range differs somewhat from that of unseeded ranges, protection during the period of establishment and management thereafter are best achieved with permanent fencing of the reseeded area.

It is especially hazardous to graze a new stand of grass the first spring after seeding, for when the ground is soft and muddy the young plants may be pulled up or trampled by grazing animals. Protection during the early part of the second growing season is also recommended. This will ordinarily permit new seedlings to develop rapidly and become well established. Early or careless use delays establishment and maximum production. It may result in failure to obtain a satisfactory stand.

Complete protection from grazing throughout the period of establishment is not always necessary (fig. 12). Moderate or light grazing during the dry summer and fall periods or in winter may not do serious harm. If it is not practicable to fence, protection from grazing can sometimes be provided by a shift in management plans whereby grazing on the entire allotment or range is deferred through the growing season.



F-397060

FIGURE 12—Lightly grazed crested wheatgrass at 6,200 feet elevation on deteriorated national-forest range that was broadcast-seeded in May 1938 after preparation with a heavy cut-out disk. Photographed in June 1940.

Thick stands of tall-growing weeds that develop after seeding may have to be mowed in late spring or early summer to hasten seedling establishment. This does not seriously damage the grass seedlings that are beginning growth. It helps to conserve soil moisture and prevents excessive shading by the weeds.

Management of established reseeded ranges differs in one important respect from management of other range lands. The objective is to maintain the reseeded species and discourage natural succession which would bring an increase of less desirable native species. On range lands generally, the objective of management is to encourage increase of the more important native species through natural succession. In other respects the basic principles of good management are equally applicable. Moderate or conservative grazing use, instead of heavy grazing, promotes sustained high yields of both native and reseeded species. Beginning when basal leaves are 3 or 4 inches in length, well-established stands of crested wheatgrass may be grazed closely enough in spring to check the accumulation of seedstalks. If this is done, livestock should be removed before hot, dry summer weather commences. The grass can then recover sufficiently to maintain good vigor.

Based on grazing trials conducted at Miles City, the recommended rate of stocking for crested wheatgrass in that general area is about $1\frac{1}{4}$ acres per animal-unit month for a 140-day period beginning in early spring. On better sites in eastern Montana, the production of herbage and the carrying capacity is even higher. Unless crested wheatgrass is grazed at about the level recommended under eastern Montana conditions, mowing in the fall may be necessary to remove old herbage which is unpalatable and unattractive to grazing animals the following year.

WILL RESEEDING PAY?

Whether or not reseeding is practical should be decided for each site by weighing all probable returns against estimated costs. In considering the returns, the long-time viewpoint should be taken, since reseeding is an investment that brings both direct and indirect benefits spread over a period of years. Taxes, interest, and carrying charges on a given piece of range land can be expected to remain about the same, whether it is reseeded or not. The decision to reseed or not to reseed a specific area depends largely, then, upon the balance between total cost of the reseeding operation and expected returns from increased quality and quantity of forage, conservation of the soil, and protection to downstream property through reduction of runoff and erosion.

The foregoing guides as to where, what, when, and how to reseed and how to manage reseeded areas, plus the current price of seed, provide a basis for closely approximating the cost of reseeding. It should be borne in mind, however, that failure may sometimes result from damage by grasshoppers or unfavorable weather, making another seeding necessary.

Perhaps the most direct benefit to accrue from reseeding is increased production of palatable herbage. This increase is due to a greater total yield and to the substitution of palatable grasses for weeds

and other plants of low value. In a grazing test at the United States Range Livestock Experiment Station near Miles City, crested wheatgrass provided nearly $2\frac{1}{2}$ times as much grazing per unit area during spring and early summer as did good native range plants on an unseeded area under moderate stocking. Numerous other weed-infested ranges now in a low state of production could be equally productive if reseeded.

The production of early or mid-summer green forage, or both, is another justification for reseeding to certain species. By pasturing adapted cool-weather species such as crested wheatgrass, animals make rapid gains 2 weeks or more earlier in the spring than on range having native species. Reseeding certain other adapted species can extend the green forage period in summer well beyond that ordinarily expected on most ranges.

Besides marked increases in herbage production and the lengthening of the green forage period, the regrassing of range lands offers certain other rewards of great value. Reseeding tends to stabilize the livestock industry by providing more dependable herbage for grazing. It helps to conserve both soil and water by reducing runoff and erosion. It increases esthetic values by covering up the unsightly evidence of past mistakes, particularly in the case of "bottom up" lands. Finally, the range manager who, by reseeding, increases the productiveness and stability of deteriorated ranges wins the considerable satisfaction of knowing that he has done his part as a good steward of the land.

COMMON AND BOTANICAL NAMES OF SPECIES MENTIONED

Bluegrass, big	<i>Poa ampla</i>
Brome, cheatgrass (downy brome, downy chess).	<i>Bromus tectorum</i>
Brome, mountain	<i>B. carinatus</i> (syns. <i>B. marginatus</i> ; <i>B. polyanthus</i> , etc.).
Brome, smooth	<i>B. inermis</i>
Douglas-fir	<i>Pseudotsuga taxifolia</i>
Fescue, hard	<i>Festuca ovina</i> var. <i>duriuscula</i>
Fescue, Idaho	<i>F. idahoensis</i>
Grama, blue	<i>Bouteloua gracilis</i>
Needle-and-thread	<i>Stipa comata</i>
Needlegrass, green	<i>S. viridula</i>
Oatgrass, tall	<i>Arrhenatherum elatius</i>
Orchard grass	<i>Dactylis glomerata</i>
Pine, lodgepole	<i>Pinus contorta</i> var. <i>latifolia</i>
Pine, ponderosa	<i>P. ponderosa</i>
Russian-thistle, tumbling	<i>Salsola kali</i> var. <i>tenuifolia</i>
Sagebrush, big	<i>Artemisia tridentata</i>
Saltgrass, inland	<i>Distichlis stricta</i>
Timothy	<i>Phleum pratense</i>
Wheatgrass, beardless	<i>Agropyron inerme</i>
Wheatgrass, bluebunch	<i>A. spicatum</i>
Wheatgrass, bluestem (western wheatgrass)	<i>A. smithii</i>
Wheatgrass, crested	<i>A. cristatum</i>
Wheatgrass, intermediate	<i>A. intermedium</i>
Wheatgrass, stiffhair (pubescent wheatgrass).	<i>A. trichophorum</i>
Wheatgrass, tall	<i>A. elongatum</i>
Wild-rye, Russian	<i>Elymus junceus</i>

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